Supplemental Specification
2005 Standard Specification Book

SECTION 02610

PIPE, PIPE-ARCH, STRUCTURAL PLATE PIPE, AND STRUCTURAL PIPE ARCH

Delete Section 02610 in its entirety and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and procedures for installing pipe.

B. Class, type, size, and thickness designations.

C. Asphalt coating for pipe.

1.2 RELATED SECTIONS

A. Section 02317: Structural Excavation

B. Section 02330: Embankment

C. Section 03055: Portland Cement Concrete

D. Section 03310: Structural Concrete

1.3 REFERENCES

A. AASHTO M 36: Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

B. AASHTO M 55: Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

C. AASHTO M 86: Concrete Sewer, Storm Drain, and Culvert Pipe

D. AASHTO M 167: Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches

E. AASHTO M 170: Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

F. AASHTO M 196: Corrugated Aluminum Pipe for Sewers and Drains

G. AASHTO M 197: Aluminum Alloy Sheet for Corrugated Aluminum Pipe

H. AASHTO M 198: Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

I. AASHTO M 207: Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe

J. AASHTO M 219: Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches

K. AASHTO M 243: Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe Arches, and Arches

L. AASHTO M 245: Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains

M. AASHTO M 246: Steel Sheet, Metallic-Coated and Polymer Precoated for Corrugated Steel Pipe

N. AASHTO M 274: Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe

O. AASHTO M 294: Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter

P. AASHTO M 304: Polyvinyl Chloride (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter

Q. AASHTO National Transportation Product Evaluation Program

R. AASHTO Standard Specifications for Highway Bridges

S. ASTM A 849: Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe

T. ASTM C 828: Standard Test Method for Low Pressure Air Test of Vitrified Clay Pipe Lines

U. ASTM C 924: Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

V. ASTM C 969: Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Sewer Lines

W. ASTM C 1103: Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

X. ASTM D 1784: Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

Y. ASTM D 3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

Z. ASTM D 3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

AA. ASTM F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe

BB. ASTM F 1417: Standard Test Method for Testing Installation Acceptance of Plastic Gravity Flow Sewer Lines Using Low Pressure Air

CC. Utah Occupation Safety and Health Regulations

1.4 DEFINITIONS

A. Pipe and Pipe Arch are identified according to diameter or by span and rise, the following definitions, and according to corrosion class.

1. Cover - The vertical extent of soil above the crown of the pipe or culvert. Refer to DG Series Standard Drawings.
2. Cross Culvert - A transverse drain, covered with embankment that allows surface runoff to pass under the embankment.
3. End Section - A structure commonly made of steel or concrete that is attached to one or both ends of a culvert or a pipe to retain the embankment, improve appearance, provide anchorage, improve discharge and limit scour at the opening.
4. Headwall - A structure, commonly made of concrete, placed at the end of culvert inlet or outlet or storm drain outlet, to anchor the pipe, to retain the highway embankment near the pipe end, and to protect the pipe ends from bank erosion and channel bed scour.
5. Invert - The floor, bottom, or lowest part of the internal cross section of a culvert, conduit or storm drain.
6. Irrigation Pipe - A pipe designed to carry seasonal irrigation water by gravity flow.

7. Paved Invert - Lining of concrete, bituminous or other materials, placed in the invert to protect the invert from abrasion or to improve the culvert hydraulics.
8. Rise - The vertical height dimension of a box, pipe arch, and arch structure.
9. Skew - The angle between a line perpendicular to the roadway centerline and the longitudinal direction of the culvert barrel.
10. Soffit - The inside top or roof of a culvert, conduit, or storm-drain pipe.
11. Span - The horizontal dimension of a box culvert, pipe arch, or arch structure.
12. Storm Drain - A closed conduit or waterway that collects and conveys storm runoff that has drainage structures at the ends of individual pipe runs such as catch basins, drop inlets, man-holes, endwalls, and other similar features by gravity flow.

B. Corrosion Classification:
1. Class A: Pipe used in mostly non-reactive soils that requires no special materials, treatments, or coatings.
2. Class B: Pipe used in moderately reactive and corrosive soils.
3. Class C: Pipe used in soils that are highly reactive and corrosive.
4. Class D: Untreated structural plate pipe used in mostly non-reactive and non-corrosive soils.
5. Class E: Structural plate pipe used in highly reactive and corrosive soils.

1.5 SUBMITTALS

A. Provide a manufacturer's Certificate of Compliance showing that furnished pipes meet or exceed the requirements in this Section, Article 2.4 paragraph A.1.

B. Provide certification that the company manufacturing HDPE pipe is enrolled in the National Transportation Product Evaluation Program (NTPEP) and that the particular pipe size they are furnishing has been tested and meets AASHTO minimum requirements for HDPE pipe.

C. Furnish a Certification of Compliance from the manufacturer certifying coating thickness.

1.6 ACCEPTANCE CRITERIA

A. General
1. Pipes are accepted according to the criteria outlined in this section. Perform the acceptance testing, or use the services of a UDOT approved third party testing company.

2. Pipes are accepted after verification that the following elements meet the specification's requirements:
   a. Horizontal and vertical alignment deviations
   b. Barrel distortion
   c. Damage to the pipe
   d. Joints
   e. Coating integrity

B. Requirements
1. Horizontal and vertical alignment deviations
2. Remove and reinstall all pipes that exceed the alignment tolerances shown in Table 1.

Table 1

Tolerances		
Installation Alignment Tolerances		
Design Grade	**Horizontal Deviation**	**Vertical Deviation ***
		inches/100feet
> 1 %	Horizontal joint deflections not to exceed industry standards	1 1/2
≤ 1 %		1
< 0.5 %		± 0.5

* For cross culverts increase tolerance by 50 percent.

3. Joints
   a. Cross Culverts - Provide pipes with joints that pass a 3 psi pressure test in the laboratory according to this Section, Article 2.4 paragraph A.
   b. Storm Drains – Provide pipes with joints that pass a 5-psi pressure test or any other pressure requirements specified in the plans. Test pipes according to this Section, Article 2.4 paragraph A.
   c. Irrigation pipe – Provide pipes with joints that pass laboratory tests for 5 psi or any other pressure requirements specified in the plans.
   d. Pipe arches and structural plate pipes are installed per manufacturer's recommendations and are not pressure rated.
4. Allowable distortions – Provide installed pipes that do not have ovaling or distortions greater then 5 percent of the nominal pipe diameter. Measure distortions using a mandrel or directly. For nominal pipe diameter larger than 48 inches, use measured diameter to calculate the 5 percent tolerance limit.

C. Inspection and testing

1. The inspection and testing is divided into two categories:
   a. Cross Culverts
   b. Storm drains and irrigation pipes.
2. Table 2 shows the inspection and testing required according to pipe category. Inspect or test with the Engineer or his representative present, the cross culverts, storm drains, and irrigation pipes installation prior to placing the roadway pavement.

Table 2

Pipe Testing Requirements According to Pipe Function					
Pipe Category and Size	**Visual**		**Physical**		**Leakage**
	Sight	**Video Recording**	**Manual Measure**	**Mandrel See Article 1.6.C6**	**Air or Water Test**
Cross Culverts ≤ 48-inch dia.		X*	X*	When visual shows non compliance with criteria in this section	
Cross Culverts > 48-inch dia.	X		X		
Storm Drains/Irrigation Pipes ≤ 48-inch dia.		X*	X*	When visual shows non compliance with criteria in this section	When visual test shows non compliance with criteria in this section
Storm Drains/Irrigation Pipe > 48-inch dia.	X		X		When visual test shows non compliance with criteria in this section

* Both methods are acceptable for pipes with diameters larger than 30-inches

3. Inspect 25 percent of all the cross culvert, storm drain installations, and irrigation pipe units, selected by the Engineer. Round to the highest whole unit. Test any pipes with apparent defects as directed by the engineer. The Department will pay the cost of any requested additional tests that show the pipe tested being in compliance with the criteria in this section.
4. Sample Unit
   a. Cross culverts, the entire length of the cross culvert.
   b. Closed conduits, such as storm-drains and irrigation pipes, the entire length of pipe between manholes or other junction structures.

5. Visual Inspection
    a. Visually inspect pipes as required in Table 2, with an Engineer's representative. Follow OSHA requirements for inspecting confined entry spaces.
    b. Provide and use a mobile color video camera with an appropriate light to show the interior of the pipe, be able to move inside the pipe barrel, and be controlled remotely by the inspector, to inspect installed pipes as required in Table 2.
    c. Provide a remote monitor and a recording apparatus for the camera, to view and record the condition of the installed pipes.
    d. Provide a digital copy of the pipe inspection video recording to the Engineer.
6. Mandrel Test - When visual inspection documents pipe deformation of concern, the Engineer can require a mandrel test according to the following criteria.
    a. Test pipe by hand pulling a fabricated mandrel through the sample unit.
    b. Provide and use mandrels to verify that the installed pipes meet the specification requirements in Table 2 of this specification.
    c. Provide the following:
        1) A mandrel, acceptable to the Engineer.
        2) A mandrel with an effective diameter equal to 95 percent of the nominal inside diameter.
        3) A proving-ring to verify mandrel size.
        4) A mandrel with a minimum of nine equally spaced runners (40 degree angles).
7. Manual Measurement
    a. Measure manually any distortions (deflections) of pipes as indicated in Table 2 and verify in the presence of the Engineer or his representative that the installed pipes sample meet the criteria in Table 2.
8. Joint Test (for Storm Drains and Irrigation Pipes only) - In addition to the inspection requirements in this Section, Article 1.6 paragraph C, test units with diameters equal to or less than 42 inches when visual inspection indicates noncompliance with the criteria in this section. Test all pipes that have joints showing visible gaps, defects, or any other problem according to one the following testing methods:
    a. Air Test
        1) Test individual joints according to ASTM C 1103.
        2) Concrete Pipe - Test according ASTM C 924.
        3) Plastic Pipe - Test according to ASTM C 828 or C 924 or F 1417 and manufacturer's recommendations.
    b. Exfiltration Test
        1) Test all pipe material types according to AASHTO M 86 and ASTM C 969.

2) Maintain head for one hour.
3) Do not exceed leakage values in Table 3.
4) Locate source or sources of leakage and repair damaged storm drain or irrigation system that does not pass the test.

Table 3

Leakage Test Allowances	
Nominal Pipe Diameter (Inches)	Maximum Leakage Allowed (Gal/hr/100 feet)
18	4.5
24	6
30	7.5
36	9
42	10.5
48	12

D. Quality Assurance

1. Repair or replace damaged or improperly installed pipes in a sample unit at the direction of the Engineer.
2. Repair according to manufacturer's recommendations pipes that fail the Joint Test in this Section, Article 1.6 paragraph C at no cost to the Department. Retest the repaired pipes. Remove and replace pipes if they fail retest.
3. Provide engineering analysis certifying the structural and hydraulic integrity of the pipe, stamped by a professional engineer registered in Utah, for all pipes that fail the mandrel test and that do not exceed 10 percent deflections, to the Resident Engineer and Central Hydraulics for the pipe acceptance.
4. Apply the pay reduction schedule in Table 4, for sample units left in place that have pipes that do not meet mandrel test requirements, if an engineering analysis is not performed:

Table 4

Payment Reductions	
PIPE DEFLECTION MEASURED	
Amount of Deflection (%)	Payment
0.0 to 5	100% of the Unit Bid Price
5.1 to 9.9	75% of the Unit Bid Price
10 or greater	Remove and Replace

5. Remove and replace all pipes that exceed 10 percent deflections.

PART 2 PRODUCTS

2.1 PIPE TYPES

A. Pipe, Pipe Arch, Structural Plate Pipe and Structural Plate Pipe Arch Types: Refer to Table 5.

Table 5

AASHTO Reference Specifications for Pipe					
Pipe Type	**Pipe Class**				
	A	**B**	**C**	**D**	**E**
Substitutions: Class B and C may be substituted for Class A, Class C may be substituted for Class B or A, Class E may be substituted for Class D.					
Corrugated Pipe and Pipe Arch:					
Corrugated steel pipe. Corrugated steel pipe arch. **(1)**	M 36	M 36 Polymeric Coating 0 µm (inside)/250 µm (outside) M 245 & M 246 ASTM A 849 or Aluminized Type II Steel M 274 (2)	M 36 Polymeric Coating 250 µm (inside)/250 m (outside) M 245 & M 246 ASTM A 849	N/A	N/A
Corrugated aluminum pipe. Corrugated aluminum pipe arch. **(1)**	M 196 M 197	M 196 M 197	M 196 M 197	N/A	N/A
Corrugated polyethylene (HDPE) pipe	M 294 ASTM D 3350	M 294 ASTM D 3350	M 294 ASTM D 3350	N/A	N/A
Smooth-Lined Pipe and Pipe Arch:					
Concrete lined corrugated steel pipe (Use Type V cement. Refer to Section 03055)	M 36	M 36 Polymeric Coating 250 µm (inside)/250 µm (outside) M 245 & M 246 ASTM A 849	M 36 Polymeric Coating 250 µm (inside)/250 µm (outside) M 245 & M 246 ASTM A 849	N/A	N/A
Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter	M 294 ASTM D3350	M 294 ASTM D3350	M 294 ASTM D3350	N/A	N/A
Smooth lined Polyvinyl chloride (PVC) pipe	M 304 Cell Class # 12454C ASTM D 1784	M 304 Cell Class # 12454C ASTM D 1784	M 304 Cell Class # 12454C ASTM D 1784	N/A	N/A

AASHTO Reference Specifications for Pipe					
Pipe Type	**Pipe Class**				
	A	**B**	**C**	**D**	**E**
Substitutions: Class B and C may be substituted for Class A, Class C may be substituted for Class B or A, Class E may be substituted for Class D.					
Spiral rib steel pipe Spiral rib steel pipe arch	M 36	M 36 Polymeric Coating 0µm (inside)/250 µm (outside) M 245 and M 246, ASTM A 849 or Aluminized Type II Steel M 274 (2)	M 36 Polymeric Coating 250 µm (inside)/250 µm (outside) M 245 and M 246 ASTM A 849	N/A	N/A
Spiral rib aluminum pipe and pipe arch	M 196 and M 197	M 196 and M 197	M 196 and M 197	N/A	N/A
Reinforced concrete pipe	M 170 Type II Cement	M 170 Type II Cement	M 170 Type V Cement required	N/A	N/A
Non-reinforced concrete pipe	M 86 Type II Cement	M 86 Type II Cement	M 86 Type V Cement required	N/A	N/A
Elliptical reinforced concrete pipe	M 207 Type II Cement	M 207 Type II Cement	M 207 Type V Cement required	N/A	N/A
Structural Plate Pipe and Pipe Arch:					
Structural steel plate pipe and pipe arch	N/A	N/A	N/A	M 167	M 167 M 243
Aluminum alloy structural plate pipe and pipe arch	N/A	N/A	N/A	M 219	M 219
Footnotes: (1) Minimum corner radii conforming to the details shown on the standard drawings. (2) Acceptable Soil Conditions, Class B, Aluminized Type II Steel are: 1.6mm minimum thickness of metal acceptable where pH is greater than 7 and less than 8.5, and soil resistivity is greater than 1500 ohm-centimeters.					

2.2 RELATED PRODUCTS

A. Asphalt Coating: Furnish Material Class M-Mastic, either asphalt or tar base, cold applied. Refer to AASHTO M 243 and ASTM A 849.

2.3 PIPE SELECTION

A. Use the same type and strength or thickness for the entire run of pipe.

B. Use the maximum height of cover to determine the strength or thickness. Refer to the DG series Standard Drawings.

C. Do not use aluminum pipe when a paved invert is required, unless protective measures are taken. Follow this Section, Article 3.7 paragraph C.

D. Corrugated and smooth-lined high density polyethylene pipes: Use only HDPE Plastic Pipe up to 60-inch diameter that is certified by AASHTO National Transportation Product Evaluation Program (NTPEP)to meet AASHTO M 294 requirements and. Provide a copy of NTPEP certification to the Engineer.

E. Corrugated and smooth-lined PVC pipes: Use up to 36 inch diameter.

F. Furnish Material Pipe Coating Class M-Mastic, either asphalt or tar base, cold applied. Refer to ASTM A 849.

G. Precast, non-reinforced concrete pipe: Use only 18 inch to 36 inch diameter.

H. Do not allow pipes of different types of metal to contact each other. Use matching materials to make direct extensions of existing pipes.

I. Do not use pipe containing longitudinal lap seams if watertight pipe or watertight joints are called for.

J. Do not use thermoplastic pipe manufactured without UV inhibitors approved by the Materials Engineer in applications subject to direct sunlight.

2.4 JOINTS OR COUPLING BANDS FOR PIPES

A. General:
   1. Furnish pipes with joints that can sustain 3 psi minimum pressure for all cross culverts or 5 psi minimum pressure for all storm-drains and irrigation pipes, tested according to the proper AASHTO and ASTM test requirements by an independent lab or witnessed by a UDOT representative, for each pipe type.
   2. Comply with manufacturer's recommendations for connecting pipes and for connecting pipes to concrete headwalls, catch basins, and similar structures.

B. Concrete Pipes:
   1. Meet AASHTO M 198.

C. Metal Pipe:

   1. Conform to AASHTO Standard Specifications for Highway Bridges and AASHTO M 36 or AASHTO M 245 with the following modifications:
      a. Use connecting bands of the same class as the pipe. Maintain a minimum thickness of 0.064 inch for the connecting bands.
      b. Use bands with projections (dimple bands) only in extension of existing pipes where annular corrugations do not exist.

c. Re-role ends of helically corrugated pipe to form at least two full annular corrugations each before being joined.
d. Use flat bands only when approved in writing by the Engineer.
e. Follow DG series Standard Drawings.

D. Test joints in the lab in accordance with ASTM D 3212.

E. Joints for PVC Pipes: Show no leakage when tested in accordance with ASTM D 3212. Meet ASTM F 477 for gaskets.

PART 3 EXECUTION

3.1 PREPARATION

A. Excavating, Trenching, Bedding and Backfill:
1. Refer to Section 02317.
2. Refer to DG series Standard Drawings.

3.2 INSTALLATION

A. Follow manufacturer installation requirements for installing all types of pipe.

B. Install pipe to conform to AASHTO Standard Specifications for Highway Bridges.

3.3 SMOOTH LINING FOR CORRUGATED STEEL PIPE AND PIPE ARCH

A. Clean all surfaces to be lined including removal of all oil and grease from the metal. Allow the surface to dry before proceeding.

B. Concrete Lining: Follow ASTM A 849, Subsections 5 and 9.

C. Asphalt Lining: no asphalt coating.

3.4 PIPE AND PIPE ARCH

A. Follow AASHTO M 243.

B. Use materials described in Table 5.

C. Remove moisture, dirt, oil, un-bonded or incompatible paint, grease residual oil, alkalies, or other foreign matter from the surface to be coated.

D. Spray or brush-coat all aluminum pipes contacting concrete with an asphalt mastic or tar base material to a minimum thickness of 0.05 inch.

3.5 STRUCTURAL PLATE PIPE AND PLATE PIPE ARCH

A. Use materials described in Table 5.

B. Repair or replace all damaged plates or coatings before installation.

C. Installation: Follow DG series Standard Drawings. Embankment: Refer to Section 02330.

D. Assembly:
1. Give the Engineer a copy of the detail plan showing the position of each plate and the assembly order.
2. Follow the manufacturer's instructions.
3. Mark clearly each modified plate, designating its position in the finished structure.
4. Place outside circumferential pipe-laps facing upstream.
5. Attain approved seam fit-up. Place and torque all bolts according to manufacturer's recommendation.
6. Form structural plates so that the finished pipe is elliptical with the vertical diameter of round pipe approximately 5 percent greater than the nominal diameter.

E. No Asphalt Coating allowed.

3.6 INVERT PROTECTION

A. Paved Invert:
1. Use corrugated steel pipe or pipe arch and structural steel plate pipe or plate pipe arch.
2. Complete backfill and embankment over the pipe before placing paved invert material.
3. Use 10 gage wire fabric with wire spaced at 6 inch centers. Refer to AASHTO M 55.
4. Arc-weld the wire mesh reinforcement to the corrugation at not more than 2 ft centers.
5. Place concrete at least 2 inches above the crest of the corrugations, at least 1/4 of the circumference of round pipe, or the span width of arch pipe. Refer to Section 03055.
6. Finish the concrete to a floated surface finish. Refer to Section 03310.

7. After curing, coat the joint between the pipe and concrete with liquid asphalt at a rate 0.9 gal/yd^2 of residual asphalt. Coat 6 inches above and below the joints.

3.7 QUALITY CONTROL

A. Provide adequate cover or protection for all pipe during project construction. Replace all damaged pipe before acceptance by the Department.

B. The following are some causes for rejection:
   1. Irregular or distorted shape (not as provided or designed)
   2. Dents or bends
   3. Damaged, broken, delaminated or scaled coating
   4. Loose bolts or nuts
   5. Uneven laps
   6. Improper fitting joints
   7. Any damage which compromises the functionality and design life of the pipe.

C. Coatings:

   1. Department will take a representative sample from each lot furnished to conduct verification testing.

END OF SECTION